DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This is mainly used for evaluation of the product in the waveguide type light part manufacture for the object for optical communication, or optical information processing about the direction change machine of polarization which changes the direction of polarization which is needed in order that this invention may measure the polarization property of passive optical-circuit parts like optical waveguide passive circuit elements.
[0002]
[Description of the Prior Art] With passive optical-circuit parts like an optical waveguide circuit, it is a very important technical problem to abolish the polarization dependency of the part.
[0003] For example, as for the quartz system light waveguide passive circuit elements which were made to deposit quartz system glass on the front face of Si substrate, and were produced, the utilization as practical passive optical-circuit parts is expected from the goodness and the smallness of optical loss of adjustment with an optical fiber. The most important technical problem of such passive optical-circuit parts is "the property should not change with the polarization states of input light." Because, most of the optical fiber already laid now is a single mode optical fiber, and a polarization state is not stabilized by the propagation light by the disturbance of the optical fiber. Therefore, in this propagation light, if branching and the passive optical-circuit parts for carrying out signal processing have a polarization dependency, the function will also be stabilized according to the polarization state of input light.
[0004] However, the optical waveguide generally produced by the substrate front face originates in the fabric anisotropy, and has the birefringence which has a main shaft in an parallel direction or the perpendicular direction to a substrate side. That is, a polarization dependency exists between TE polarization light which has an electric-field component in the direction parallel to a substrate side, and a substrate side and TM polarization light which has an electric-field component perpendicularly. The biggest technical problem for putting waveguide type light parts in practical use is canceling this polarization dependency.
[0005] As a polarization dependency canceling method of waveguide type light parts, the method of carrying out laser trimming of the stress grant film, the method of loading a different-species thin film, etc. are proposed. However, in order to cancel the polarization dependency with a sufficient precision, the measuring device which evaluates the polarization dependency often precision] and easily is required.
[0006] Conventionally, there were the following two methods in evaluation of the polarization property of waveguide type light parts.
[0007] (The conventional technology 1) The method by which a polarization maintenance optical fiber with a thin film polarizer is used as an input fiber, this is rotated mechanically, and the polarization property of waveguide type light parts is evaluated.
[0008] (The conventional technology 2) The method by which the polarization property of waveguide type light parts is evaluated by inserting 1/2 wavelength plate into this, and rotating the angle mechanically, using a polarization maintenance optical fiber as an input fiber.
[0009] Drawing 1 shows the outline composition of the polarization property measuring device which adopted the polarization characterization method of 1 of the above-mentioned conventional technology. Here, the polarization maintenance optical fiber with a thin film polarizer in which 20 has the thin film polarizer by which a polarization maintenance optical fiber and 3 are marketed by the optical channel selector, and 42 is marketed [the light source with a wavelength of 1.3 micrometers and 21] for the light source with a wavelength of 1.55 micrometers, and 43 and 44 in the name of the "lamination pole" (trademark), respectively, and 41 are optical fiber slewing gears. Moreover, 25 is a light power meter for the waveguide type light parts as a device under test and 45 measuring a single mode optical fiber, and 31 measuring the optical insertion loss of a device under test. With equipment, the polarization maintenance optical fiber 42 with a lamination pole thin film polarizer is used as an input fiber of a device under test 25 conventionally [this]. The input polarization state to a device under test 25 can be specified to direct polarization by this, and the property of a device under test 25 can be evaluated. Furthermore, the dependency over the input polarization of a device under test 25 can also be evaluated by rotating the input optical fiber 42 with the optical fiber slewing gear 41.
[0010] The above-mentioned lamination pole (multilayered-film polarizer) starts thinly what piled up about about 200-layer a metal thin film and 70 micrometers of dielectric thin films (SiO_2) by turns in thickness of about 30 micrometers, as shown in the sign 53 of drawing 2 . When light passes this thin film, the light with an electric-field component parallel to a metal thin film is absorbed, and the light with an electric-field component perpendicular to a metal thin film is penetrated. As this result, this thin

film functions as a polarizer. The advantage of this thin film polarizer is small, and is functioning as a polarizer in the latus wavelength field covering 1.3 micrometers - 1.6 micrometers. A linearly polarized wave can be made to always output from the outgoing end side of the polarization maintenance optical fiber 52 by doubling the direction of a metal membrane of a thin film polarizer 53, and the principal stress direction of the polarization maintenance optical fibers 51 and 52, and connecting, as shown in drawing 2 .

[0011] Drawing 3 shows the outline composition of the polarization property measuring device which adopted the polarization characterization method of the aforementioned conventional technology 2. Here, for the light source and 62, as for 1/2 wavelength plate and 64, a collimate lens and 63 are [61 / a condenser lens and 65] polarization maintenance optical fibers. Conventionally [this], with equipment, by inserting 1/2 wavelength plate 63 in the input optical fiber 65 of a device under test 25, and rotating the angle of the 1/2 wavelength plate 63, the input polarization state of a device under test 25 is changed, and the dependency is measured.

[0012] Therefore, after making a linearly-polarized-wave state from the above-mentioned polarization maintenance optical fiber 42 with a thin film polarizer first and collimating the light of the linearly polarized wave to the collimated beam in air with a collimate lens 62, 1/2 wavelength plate 63 is passed, it extracts with a condenser lens 64 further, and incidence is carried out to the polarization maintenance optical fiber 65. The polarization state in the outgoing end of this polarization maintenance optical fiber 65 can be changed by rotating 1/2 wavelength plate 63.

[0013]

[Problem(s) to be Solved by the Invention] The feature of the measuring device of the above-mentioned conventional technology 1 is in the point that the polarization property of a device under test can be evaluated in a latus light wave length field. However, in this measuring device, in order to measure a polarization property, you have to rotate the input fiber 42. At this time, precise evaluation of the polarization property of a device under test 25 had the problem of being difficult, by position gap of the input fiber 42 produced inevitably.

[0014] Moreover, in the measuring device of the above-mentioned conventional technology 2, when changing the input polarization state to a device under test 25, it is not necessary to move the input fiber 65. Therefore, since there is no change of the optical axis of input light, if the optical loss when rotating 1/2 wavelength plate 63 beforehand is measured, precise evaluation of the polarization property of a device under test 25 is possible. However, in this measuring device, since the wavelength plate 63 was used, there was a problem that the wavelength of the light source which can be used was limited by the wavelength plate 63.

[0015] Then, the purpose of this invention is to offer the possible direction change machine of polarization of canceling the trouble in the conventional polarization characterization method of waveguide type light parts as shown in the conventional technology 1 and 2, and evaluating the polarization property of waveguide type light parts precisely [are a latus light wave length range ranging from 1.3 micrometers to 1.6 micrometers, and].

[0016]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, it is characterized by having two polarization maintenance optical fibers which connect these to an Nx2 light space switch and a 2x2 polarization maintenance optical coupling machine, and twisting one fiber of two aforementioned polarization maintenance optical fibers 90 degrees to the fiber of another side, and attaching the direction change machine of polarization of this invention.

[0017] Moreover, this invention is waveguide type wavelength a non-depended coupler in which the aforementioned 2x2 polarization maintenance optical coupling machine has the structure of a Mach TSUENDA light interferometer as the one gestalt, and it is characterized by inserting the thin film polarizer into two aforementioned polarization maintenance optical fibers, respectively.

[0018]

[Function] As mentioned above, the direction change machine of polarization of this invention consists of two polarization maintenance optical fibers which connect between these to an N(arbitrary positive integers) x2 light space switch and a 2x2 polarization maintenance optical coupling machine, and the polarization maintenance optical fiber of one of these is twisted 90 degrees to the polarization maintenance optical fiber of another side. For this reason, the directions of polarization by which incidence is carried out to an optical coupling machine differ 90 degrees by which [of two polarization maintenance optical fibers] was spread. Therefore, the direction of polarization of the output light of a 2x2 polarization maintenance optical coupling machine can be rotated 90 degrees by the change of an Nx2 light space switch. As a rolling mechanism of polarization, since this direction change machine of polarization uses the twist of a polarization maintenance optical fiber, it does not have a wavelength dependency.

[0019] Therefore, since the precise polarization property of a device under test can be evaluated since there is no relative position change with the optical parts (device under test) and input optical fiber to evaluate when changing the direction of polarization of the input light, and there is no wavelength dependency in the change of the direction of polarization, the polarization characterization equipment which used the direction change machine of polarization by this invention can estimate a polarization property in the latus wavelength range.

[0020]

[Example] Hereafter, with reference to a drawing, the example of this invention is explained in detail.

[0021] Drawing 4 shows the outline composition of the direction change machine of polarization of one example of this invention. The direction change machine of polarization of this example consists of the polarization maintenance optical fiber 2 with a three lamination pole thin film polarizer connected to the light source (un-illustrating), the optical channel selector 3 using

the reflecting mirror as a 3x2 light space switch, waveguide type wavelength a non-depended coupler 12 and as a 2x2 polarization maintenance optical coupling machine, and a polarization maintenance optical fiber 1 with a two lamination pole thin film polarizer that connects these [3 and 12]. Since the composition of the lamination pole (brand name) thin film polarizer 13 is the same as that of what was shown with the sign 53 of drawing 2 , the detail is omitted.
[0022] What was produced so that it might become about 50% of binding fraction ranging from 1.2 micrometers to 1.6 micrometers is used for the waveguide type wavelength non-depended coupler 12. This coupler Already Work"Mach-Zehnder, such as KJinguji Interferometer Ratio." Type (a wavelength smoothing binding fraction) Optical Waveguide Coupler with Wavelength-flattened Coupling Mach-Zehnder-interferometer type optical-waveguide coupler Electron which it has Lett. As reported to issue in 1326 or vol.26, No.17, and p. 1990 The flame depositing method, a photolithography, and a reactive-ion-etching method are used and embedded on a silicon substrate, and the mold single mode glass waveguides 4, 5, 6, 7, 8, and 9 are produced. At this time, on the core glass of this waveguide, germanium is doped so that a refractive index may become high 0.3% rather than surrounding clad glass. The pattern is a Mach-Zehnder interferometer and consists of two directional couplers 10, arm waveguides 6 and 7 of 11 or 2 unsymmetrical length, and every two I/O waveguides 4, 5, 8, and 9.
[0023] The property of the waveguide type wavelength non-depended coupler 12 of drawing 4 is shown in drawing 5 . This view shows that the waveguide type wavelength non-depended coupler 12 is 50% of binding fraction in [latus wavelength] 1.3 micrometers - 1.6 micrometers. Moreover, since a birefringence exists in the waveguide, there is no conversion in the mode of waveguide type wavelength 12 non-depended coupler between TE polarization and TM polarization.
[0024] In the polarization maintenance optical fibers 1 and 2 with a lamination pole thin film polarizer, only the light which has the electric-field component of the principal stress direction of a polarization maintenance optical fiber is penetrated. In the polarization maintenance optical fiber 1 with a two lamination pole thin film polarizer which connects the waveguide type wavelength non-depended coupler 12 to the channel selector 3, as shown in the signs A and B of drawing 4 , compared with the fiber of another side, a fiber will be twisted one fiber 90 degrees, and it is attached.
[0025] Next, change operation of the direction of polarization in this example of drawing 4 is explained. The arbitrary light from the light source which is not illustrated passes along the polarization maintenance optical fiber 2 with a lamination pole thin film polarizer, and incidence is carried out to the optical channel selector 3 in the state of a linearly polarized wave. The incident light can be made to output to either of two output ports by moving an internal reflecting mirror to a mechanical (mechanical) in the optical channel selector 3. At this time, the polarization modes in the inside of the waveguide type wavelength non-depended coupler 12 differ by whether it is outputted to which polarization maintenance optical fiber 1 with a lamination pole thin film polarizer. However, in the waveguide type wavelength non-depended coupler 12, since the binding fraction is always 50%, whichever it was not based on light wave length, but it has passed through the polarization maintenance optical fiber 1 with a lamination pole thin film polarizer, the output luminous intensity of the waveguide type wavelength non-depended coupler 12 is equal.
[0026] Therefore, if it says about the output light of the waveguide type wavelength non-depended coupler 12, the direction of polarization can be changed by changing the optical channel selector 3, without changing optical intensity. And since this direction change machine of polarization is not using the wavelength plate etc., it has the feature of not having a wavelength dependency. In fact, the binding fraction of the waveguide type wavelength non-depended coupler 12 is slightly shifted from 50%. however, the thing for which this takes the below-mentioned reference beforehand -- an amendment -- since things are made, it is satisfactory
[0027] Drawing 6 shows the outline composition of the polarization property measuring device by this invention incorporating the direction change machine of polarization of drawing 4 . It is necessary to reduce the polarization dependency and a wavelength dependency as much as possible in passive optical-circuit parts. The equipment which measures a polarization property with a sufficient precision in the latus wavelength range for that purpose is required. Drawing 6 shows the system of measurement by this invention for measuring the polarization property of waveguide type light parts with a sufficient precision in a latus wavelength field.
[0028] Two or more light sources with which the polarization property measuring device of this example consists of the light source 20 with a wavelength of 1.3 micrometers, the light source 21 with a wavelength of 1.55 micrometers, and the white light source 22, The self-aligning equipment 24 for the alignment which doubles the optical axis of the direction change machine 23 of polarization of the composition of drawing 4 by this invention, a device under test (waveguide type light parts) 25 and the input polarization maintenance optical fiber 26, and the output single mode optical fiber 27, and the quantity of light of a reference beam By whether the measurement of the optical spectrum analyzer 32 for measuring the spectrum of the light power meter 31 for measuring the light power meter 30 for measuring and the optical insertion loss of a device under test 25 and the transmitted light of a device under test 25, and 31 and 32 of which is performed It consists of a channel selector 33 which changes an optical path, and a microcomputer 34 which manages these operations. 28 and 29 are single mode optical fibers.
[0029] Next, with reference to drawing 6 , order is explained for the method of the concrete measurement in this example later on.
[0030] First, a reference is taken. Therefore, a device under test 25 is demounted and the difference of both the outputs of with reliance, a light power meter 30, and a light power meter 31 is directly measured for the I/O fibers 26 and 27 using a microcomputer 34. It is measurement of this reference I1-O1 of the input/output terminal of the 3x2 light channel selector 3, I1-O2, I2-O1, I2-O2, I3-O1, and I3-O2 It carries out to six states connected, respectively, respectively. This is for compensating the waveguide type wavelength non-depended coupler 12, the wavelength dependence property which the optical channel selector 3 has slightly, and a polarization dependency.

[0031] Next, a device under test 25 is set among the I/O fibers 26 and 27 of self-aligning equipment 24. At this time, it sets so that the direction of the principal stress of the input polarization maintenance optical fiber 26 may become at a level with the substrate side of a device under test 25, and perpendicular. In this state, self-aligning equipment 24 is driven, three opticals axis are adjusted, and the optical axis of the I/O fibers 26 and 27 to a device under test 25 is fixed.
[0032] Next, they are the outputs O1 or O2 of the optical channel selector 3 about the property of as opposed to [choose the one light source according to the purpose from 20, 21, and 22, and] the two polarization (TE polarization, TM polarization). By choosing, it measures, respectively. However, this measurement is measuring the difference of a light power meter 30 and a light power meter 31. By compensating this measurement result with the reference measured beforehand, the precise evaluation is realizable.
[0033] Although the example which uses the waveguide type wavelength non-depended coupler 12 has been explained as a polarization maintenance optical coupling machine above, it writes in addition that it is also possible to substitute for the polarization maintenance optical fiber coupler which instead welded two polarization maintenance optical fibers.
[0034] Furthermore, it writes in addition that it is also possible to substitute for the optical channel selector using the optical space switch of 2x2 which can change an optical path as a polarization maintenance optical coupling machine 12, with polarization maintenance carried out, for example, a reflecting mirror.
[0035]
[Effect of the Invention] That is [as explained above, since the 90 degree twist of a polarization maintenance optical fiber is used, according to this invention, there is no wavelength dependency as a rolling mechanism of polarization], the direction change machine of polarization which does not exist in light wave length but can change the direction of polarization is obtained.

[0036] Therefore, manufacture of the waveguide type light parts used in the latus light wave length field ranging from 1.3 micrometers to 1.6 micrometers and precise evaluation of a polarization property are possible by using the polarization property measuring device using the direction change machine of polarization by this invention. The optical waveguide passive circuit elements which furthermore suppressed the polarization property strictly by this evaluation can be manufactured.
[0037] If it puts in another way, since the precise polarization property of a device under test can be evaluated since there is no relative position change with the optical parts (device under test) and input optical fiber to evaluate when changing the direction of polarization of the input light, and there is no wavelength dependency in the change of the direction of polarization, the polarization characterization equipment which used the direction change machine of polarization by this invention can estimate a polarization property in the latus wavelength range.

[Translation done.]